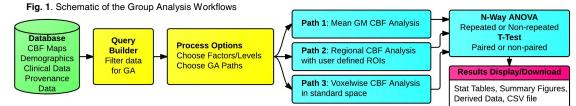
## Automated Group Analysis Tools for CBF Measures using CBFBIRN Database and Analysis Pipeline

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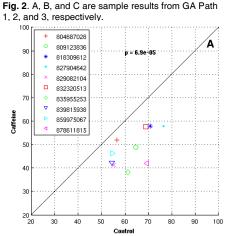
Introduction: Arterial spin labeling (ASL) is increasingly recognized as a reliable MR imaging method for measurement of cerebral blood flow (CBF). As ASL protocols are becoming

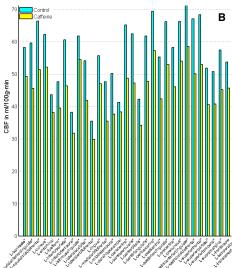


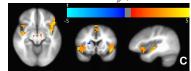
more accessible to research and clinical sites around the world, the depth and breadth of collected CBF data underscore a need for a federated data repository. To that end, we developed the CBF Database and Analysis Pipeline (CBFDAP), which was first introduced to the MR research community during 2011 ISMRM [1]. Via a simple web interface (https://cbfbim.ucsd.edu) with user login ID/password, users can upload raw data, process, and store quantified CBF maps in a user-friendly and time efficient manner. To date, the database hosts CBF maps and associated demographics/clinical assessments from more than 1300 individual subjects. These data have been contributed by more than 20 different research studies, investigating the effect on CBF of various conditions including Alzheimer's disease, schizophrenia, bipolar disorder, depression, traumatic brain injury, HIV, caffeine usage, and Methamphetamine abuse. In order to facilitate the mining and discovery of clinically useful information from such rich set of data available in our repository, we have built a set of group analysis (GA) tools and integrated them into the CBFDAP.

Methods: Fig. 1 shows a schematic of the workflows associated with the CBFBIRN group analysis. Defining process options, initiating/monitoring job status, visualizing, and downloading results are all executed via the same web interface described above. The group analysis begins with a selection of the processed CBF maps using user-specified criteria. The built-in query builder can select a subset based on several filter criteria including: CBF quantification options used, quality of the CBF maps, and subject demographics/clinical assessments. As an example, it is straightforward to select data from male schizophrenic patients aged 30 or above and from gender/age matched healthy controls to look at CBF differences between these two groups. The system then locates the selected CBF maps and associated clinical assessments from the database and presents the user with the factors/factor levels that are available for the analysis. Gender and diagnosis are examples of factors and their corresponding factor levels are male/female and controls/schizophrenic patients, respectively. Three types of group analysis are supported by the CBFDAP, Path 1: whole-brain mean gray matter (GM) CBF analysis; Path 2: regional CBF analysis with user defined ROIs; and Path 3: voxel-level standard space analysis. For Path 2, users are able to upload subject-specific ROI files (e.g. FreeSurfer parcellation maps) and associate each file with a specific subject in the database. For Path 3, the system automatically warps individual CBF maps to standard Talairach space using the anatomical data as the base template. Once the job is initiated, the system decides whether or not the data were collected with a repeated measures design by analyzing the structure of the data set, then invokes an appropriate statistical test based on the number of factors and factor levels selected by the user (Fig. 1). Upon job completion, a notification email is sent to the user and processed results are

**Results & Discussion:** On the website, a Results Summary page lists all processed jobs for a given project. Each job has a link that opens up a scrollable popup window containing all group analysis results. Fig. 2 A, B, and C show sample







outputs from Path 1, 2, 3, respectively. Fig. 2A shows changes in mean GM CBF in 10 healthy volunteers before/after 200mg caffeine intake. Fig. 2B shows regional CBF changes from the same caffeine study. The x-axis corresponds to brain regions as defined by the user-supplied masks and significance (p<0.05) is indicated by the asterisk symbol at the end of each label. Fig. 2C shows a t-map highlighting regions significantly (p<0.01) affected by schizophrenia in a standard-space analysis. The popup window also includes a description of the factors/factor levels selected by the user, the statistical test invoked, a table summarizing the test results, and contents of the CSV file containing CBF/demographics/assessments data. All results can be downloaded to a local machine so users can perform additional analysis if necessary. **Conclusion:** Building upon previous capabilities [1], we have implemented a comprehensive platform for addressing all aspects of ASL data processing, starting with data upload/storage, CBF quantification, and now the added support for three common types of group analysis, enabling researchers and general database users to minimize the time it takes to discover and report clinically useful findings regarding CBF from the CBFBIRN Database. **References:** [1] Shin et al, Abstract #4010, ISMRM, 2011.

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visually presented in the Results Summary section of the web interface.